CLAIMS

What is claimed is:

1. A capillary pump loop (CPL) cooling system, comprising:

a first evaporator, adapted to be thermally coupled to a first semiconductor heat source, including a cavity in which a working fluid is evaporated from a liquid state into a vapor state and having a liquid inlet port to receive the working fluid in a liquid state and a vapor outlet port from which the working fluid exits the evaporator in a vapor state;

a first wicking structure, having an input side to receive the working fluid in a liquid state and including a plurality of capillary channels to draw the working fluid into the evaporator through a capillary transport mechanism;

a first condenser to condense the working fluid from a vapor state into a liquid state, having a vapor inlet port to receive the working fluid in its vapor state and a liquid outlet port from which the working fluid exits the condenser in its liquid state;

a vapor transport line operatively coupling the vapor output port of the evaporator to the vapor inlet port of the condenser; and

a liquid transport line operatively coupling the liquid output port of the condenser to the liquid inlet port of the evaporator.

2. The CPL cooling system of claim 1, wherein the first wicking structure is disposed within the cavity in the evaporator.

3. The CPL cooling system of claim 1, wherein the first condenser further includes an internal cavity in which a volume of the working fluid is maintained in its liquid state, thereby functioning as a reservoir in addition to a condenser.

4. The CPL cooling system of claim 1, further comprising a reservoir having an inlet operatively coupled to the liquid outlet port of the first condenser via a first portion of the liquid transport line and an outlet operatively coupled to the liquid inlet port of the evaporator via a second portion of the liquid transport line.

5. The CPL cooling system of claim 1, wherein the first wicking structure comprises a volume of a sintered material.

6. The CPL cooling system of claim 5, wherein the sintered material comprises a sintered copper.

7. The CPL cooling system of claim 1, wherein the first wicking structure comprises a piece of meshed material disposed within the evaporator.

8. The CPL cooling system of claim 1, further comprising:

a second evaporator adapted to be thermally coupled to a second semiconductor heat source, including a cavity in which a working fluid is evaporated from a liquid state into a vapor state and having a liquid inlet port to receive a portion of the working fluid in a liquid state and a vapor outlet port from which a portion of the working fluid exits the evaporator in a vapor state;

a second wicking structure, having an input side to receive the working fluid in a liquid state and including a plurality of capillary channels to draw the working fluid into the evaporator through a capillary transport mechanism;

a vapor transport line connection segment operatively coupling the vapor outlet port of the second evaporator to the vapor transport line; and

a liquid transport line connection segment operatively coupling the liquid inlet port of the second evaporator to the liquid transport line.

9. The CPL cooling system of claim 1, further comprising a heatsink thermally coupled to the condenser.

10. The CPL cooling system of claim 9, further comprising a fan disposed relative to the heatsink so as to draw air across the heatsink when the fan is operated.

11. The CPL cooling system of claim 1, wherein the working fluid comprise water.

12. The CPL cooling system of claim 1, further comprising:

a second condenser to condense a portion of the working fluid from a vapor state into a liquid state, having a vapor inlet port to receive the working fluid in its vapor state and a liquid outlet port from which the working fluid exits the condenser in its liquid state;

a vapor transport line connection segment operatively coupling the vapor inlet port of the second condenser to the vapor transport line; ; and

a liquid transport line connection segment operatively coupling the liquid output port of the second condenser to the liquid transport line.

13. The CPL cooling system of claim 1, wherein at least a portion of each of the liquid transport line and the vapor transport line is flexible.

14. The CPL cooling system of claim 1, wherein the components of the cooling system are configured to operate in a computer server having a 1U form factor.

15. A condenser, comprising:

a single coil of tubing having a helical configuration and including an inlet port to receive a working fluid in a vapor state and an outlet port from which the working fluid exits the condenser in a liquid state; and

a plurality of fins disposed about a centerline of the single coil of tubing.

16. The condenser of claim 15, further comprising a low-profile centrifugal fan disposed within the single coil of tubing and operatively coupled to the single coil of tubing, said low-profile centrifugal fan including a motor coupled to a fan rotor comprising a plurality of fan blades that when rotated by the motor cause air to flow over the plurality of fins to assist in removing heat from the condenser.

Rule 1/26/18. 17. A thin-profile condenser, comprising:

a cover plate;

a channeled base member having an external wall extending around a periphery thereof to which the cover plate is secured so as to define a sealed cavity, and further including at least one internal wall including a portion disposed substantially adjacent to a portion of the external wall so as to define a capillary channel, said at least one internal wall dividing the sealed cavity into a condensing region and the capillary channel;

an vapor inlet port to receive a working fluid in a vapor state operatively coupled to the sealed cavity; and

a first liquid outlet port from which the working fluid exits the condenser, operatively coupled to an outlet end of the capillary channel.

~~19.~~ 18. The thin-profile condenser of claim 18, further comprising a charge port operatively coupled to the condenser to enable the condenser to be charged with the working fluid.

~~18.~~ 19. The thin-profile condenser of claim 18, further comprising a hole extending through the condensing region.

19. 20. The thin-profile condenser of claim 18, wherein said at least one internal wall includes wall portions that are configured so as to thermally isolate the capillary channel from the condensing region.

20. 21. The thin-profile condenser of claim 18, wherein said at least one internal wall includes portions that are configured symmetrically so as to form a centrally-disposed condensing region connected to a first capillary channel disposed on a first side of the condensing region and a second capillary channel disposed on a second side of the condensing region opposite of the first side.

21. 22. The thin-profile condenser of claim 20, further comprising a second liquid outlet port operatively coupled to an outlet end of the second capillary channel.

22. 23. The thin-profile condenser of claim 18, further comprising a plurality of post disposed within the condensing region extending between the channeled base member and the cover plate.

23. 24. The thin-profile condenser of claim 18, further comprising a heatsink thermally coupled to the cover plate.

24. 25. The thin-profile condenser of claim 23, wherein the heatsink comprises a base plate having a plurality of pins extending upward therefrom.

25. 26. The thin-profile condenser of claim 23, further comprising a centrifugal fan including an annular fan rotor having a plurality of fan blades disposed around a periphery of the heatsink so as to draw air across the heatsink when rotated.

26. 27. An evaporator, comprising

a base in which a cavity is defined within a peripheral portion thereof and configured to be thermally coupled to a semiconductor heat source;

a top cover secured to the peripheral portion of the base so as to define a sealed volume in which a working fluid is vaporized;

a liquid inlet port to receive the working fluid in a liquid state, operatively coupled to the sealed volume;

a vapor liquid inlet port from which the working fluid exits the evaporator in a vapor state, operatively coupled to the sealed volume; and

a wicking structure, disposed within a portion of the cavity, having a top surface on which a meniscus of the working fluid is formed and a bottom surface into which the working fluid is drawn through a capillary mechanism and a pressure differential between a pressure of the working fluid in the meniscus and a pressure of vaporized working fluid in the sealed volume.

27. 28. The evaporator of claim 26, further comprising a plurality of structural elements extending between the base and the top cover so as to prevent the sealed volume from collapsing when the evaporator is operated such that evaporation of the working fluid occurs under sub-atmospheric conditions.

28. 29. The evaporator of claim 26, wherein the wicking structure comprises a volume of a sintered material.

29. 30. The evaporator of claim 27, wherein the sintered material comprises a sintered copper.

30. 31. The evaporator of claim 27, wherein each of the base and the top cover comprise stamped metal components.